

Climate and Clean Energy Research in EBNN* Directorate

*EBNN: Environmental, Biology, Nuclear Science, and Nonproliferation Directorate

Dr. Martin Schoonen, Associate Laboratory Director EBNN

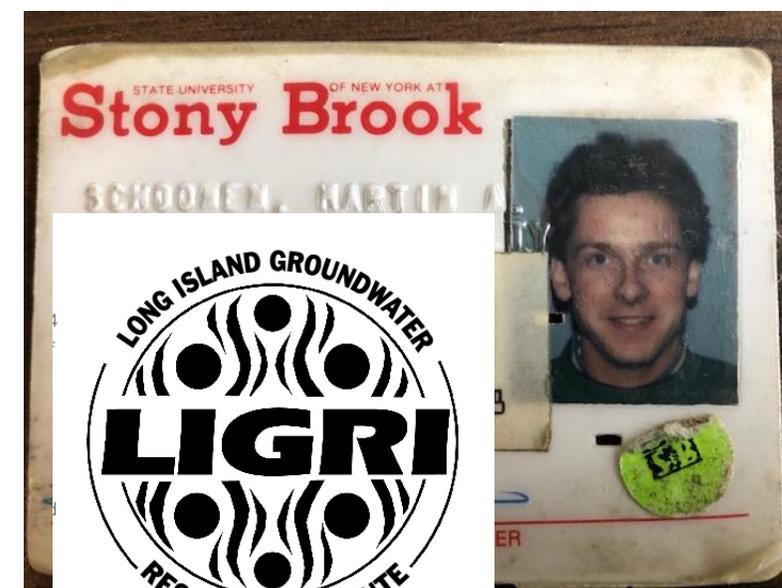
CAC meeting April 8th, 2020



@BrookhavenLab

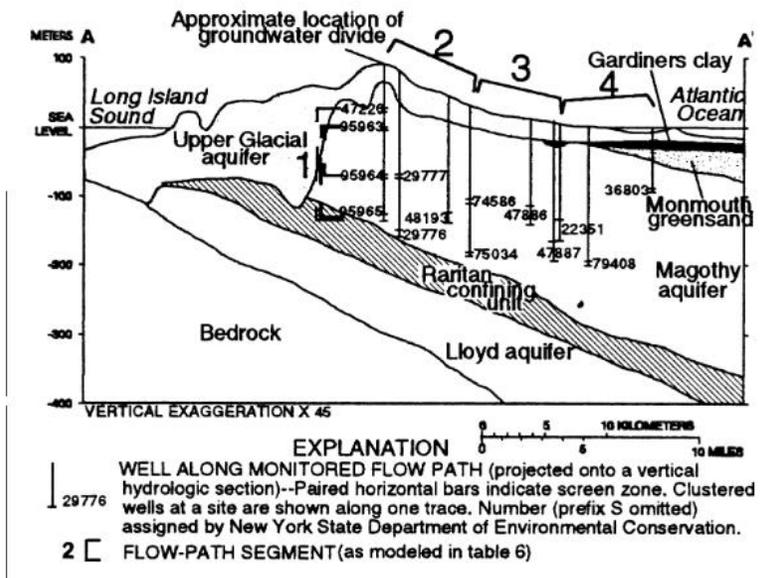
My route to BNL

- At SBU since 1989, faculty in Geosciences
- Associate Director LI Groundwater Institute
- Alternate Member Pine Barrens Advisory Committee
- Founding Dean Stony Brook-Southampton, focused on sustainability
- Chair Environmental and Climate Sciences at BNL (2013)
- Associate Laboratory Director (2014)



Geochemical modeling of iron, sulfur, oxygen and carbon in a coastal plain aquifer

C.J. Brown^{a,*}, M.A.A. Schoonen^{b,c}, J.L. Candela^d



Biden-Harris Climate Goals and Plans

- **Ensure the U.S. achieves a 100% clean energy economy and reaches net-zero emissions no later than 2050.**
 - *enforcement mechanism of targets*
 - *R&D investment in clean energy and climate research*
 - *Incentivize deployment of clean energy innovations*
- **Build a stronger, more resilient nation.**
 - *smart infrastructure resilient to climate change*
- **Rally the rest of the world to meet the threat of climate change.**
 - *Lead by example*
 - *Rejoin Paris Climate Accord*
- **Stand up to the abuse of power by polluters who disproportionately harm communities of color and low-income communities.**
 - *Strive for environmental equity*

Environment, Biology, Nonproliferation and Nuclear Science



BNL/DOE Facilities

Priorities

- Fundamental and applied atmospheric and climate science research to improve Earth System Models and support development of renewables
- Fundamental plant science research to support development of US bioeconomy
- Materials research to support US nuclear energy option
- Science and technology in support of national security and nuclear nonproliferation

Partners/Joint Appointments

University	National Lab	Industry	New York State
 Stony Brook University	 Argonne NATIONAL LABORATORY	 GE	 nyserda Energy. Innovation. Solutions.
 CSH	 Pacific Northwest NATIONAL LABORATORY	 DOW	
 ILLINOIS	 Idaho National Laboratory	 Westinghouse	
 Yale	 The City College of New York	 Raytheon	
	 OAK RIDGE NATIONAL LABORATORY MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY		

BNL Climate Science Research

Ecosystem Science

- CO₂ uptake in plants
- Biological response to warming and elevated CO₂

Atmospheric Sci.

- Cloud Formation and Fate
- Aerosol Formation and Fate
- Next generation observations

Improving Climate Predictability

Sea level
Wind & rain patterns
Seasonal temperatures
Duration growing season

Extreme Events:

- *Heatwaves*
- *Hurricanes*
- *Droughts*
- *Wild fires*

Broad Societal Impacts

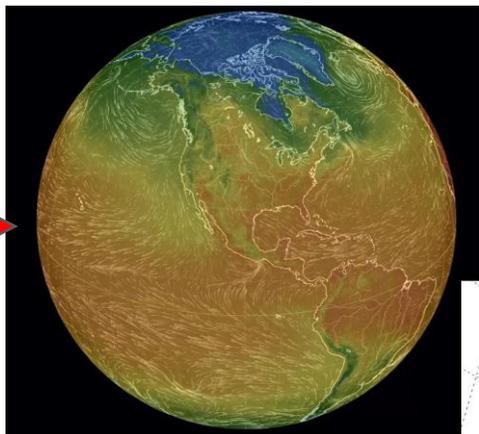
- Food security
- Infrastructure resiliency
- Water availability
- Public health
- Scale & scope climate mitigation/adaptation

Energy Sector Impacts

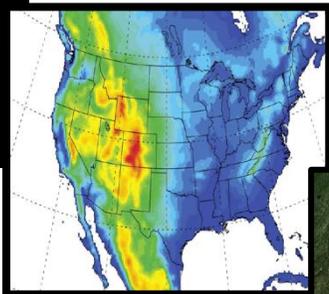
- Vulnerability of infrastructure
- Energy demand
- Yield of bioenergy crops, wind energy, solar

Research Strategy

Global Models



**Regional Models
(18km)**



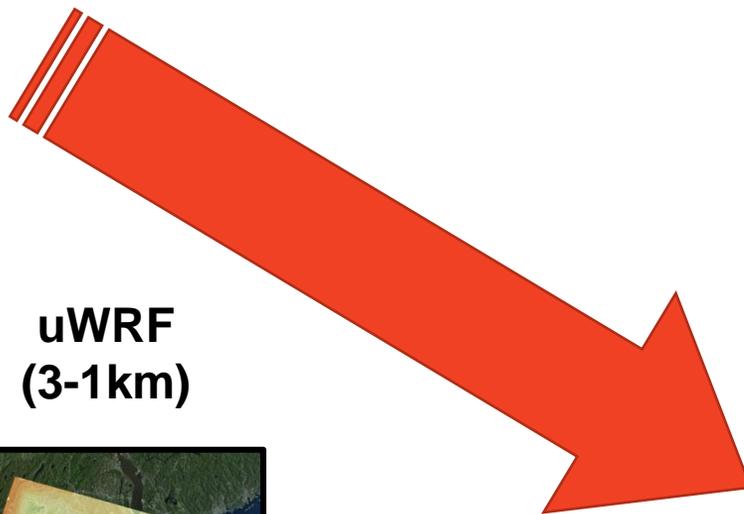
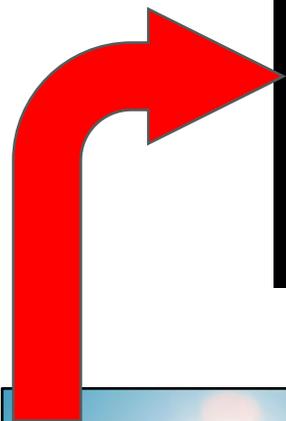
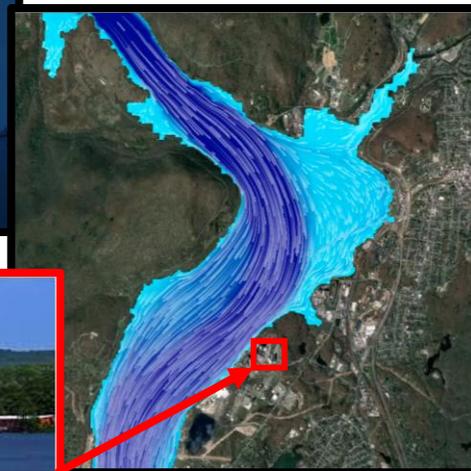
**uWRF
(3-1km)**



**Hydrologic/
Coastal
Models**



**Local scale
models**



Ecosystem Research

Plants absorb one-third of anthropogenic carbon dioxide emissions.

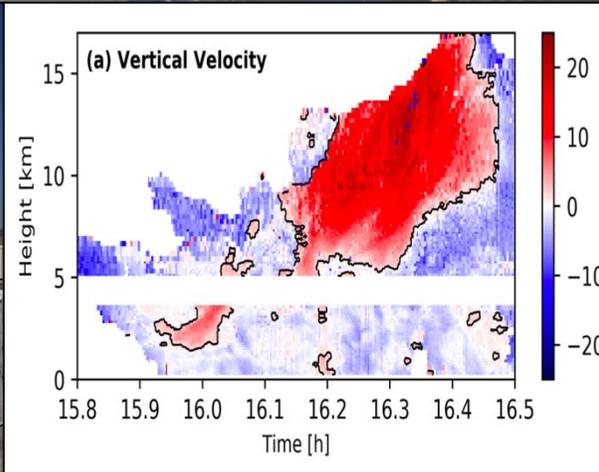
Will ecosystems around the world continue to provide this service in a changing climate?



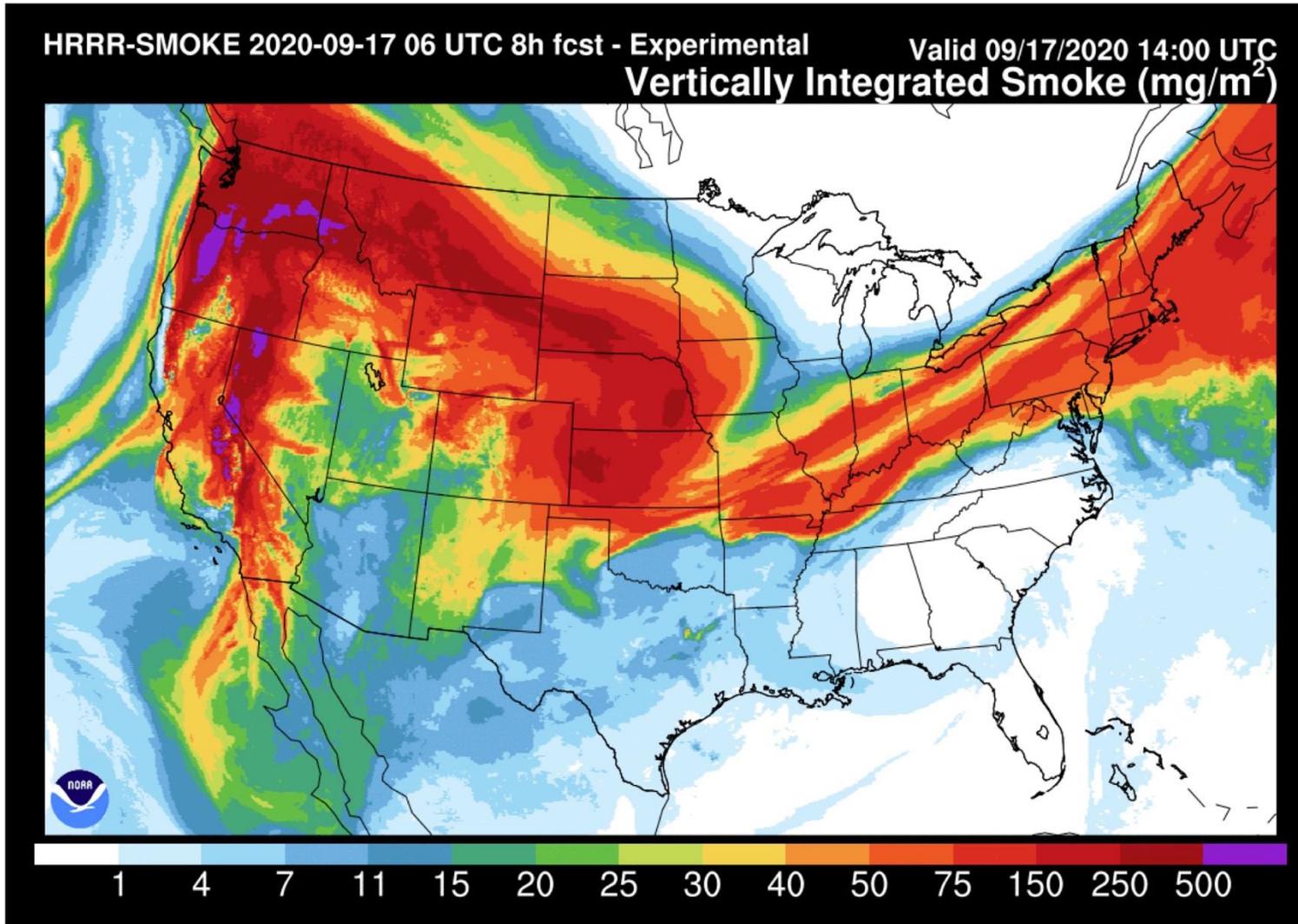
Warming experiment on the Arctic tundra



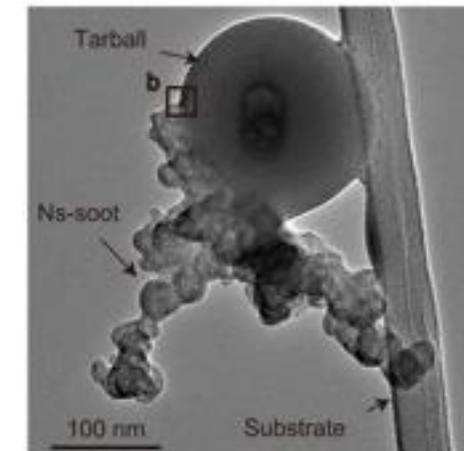
Storm Evolution and Severe Weather R&D



Wildfire-generated Aerosols and their impact on climate



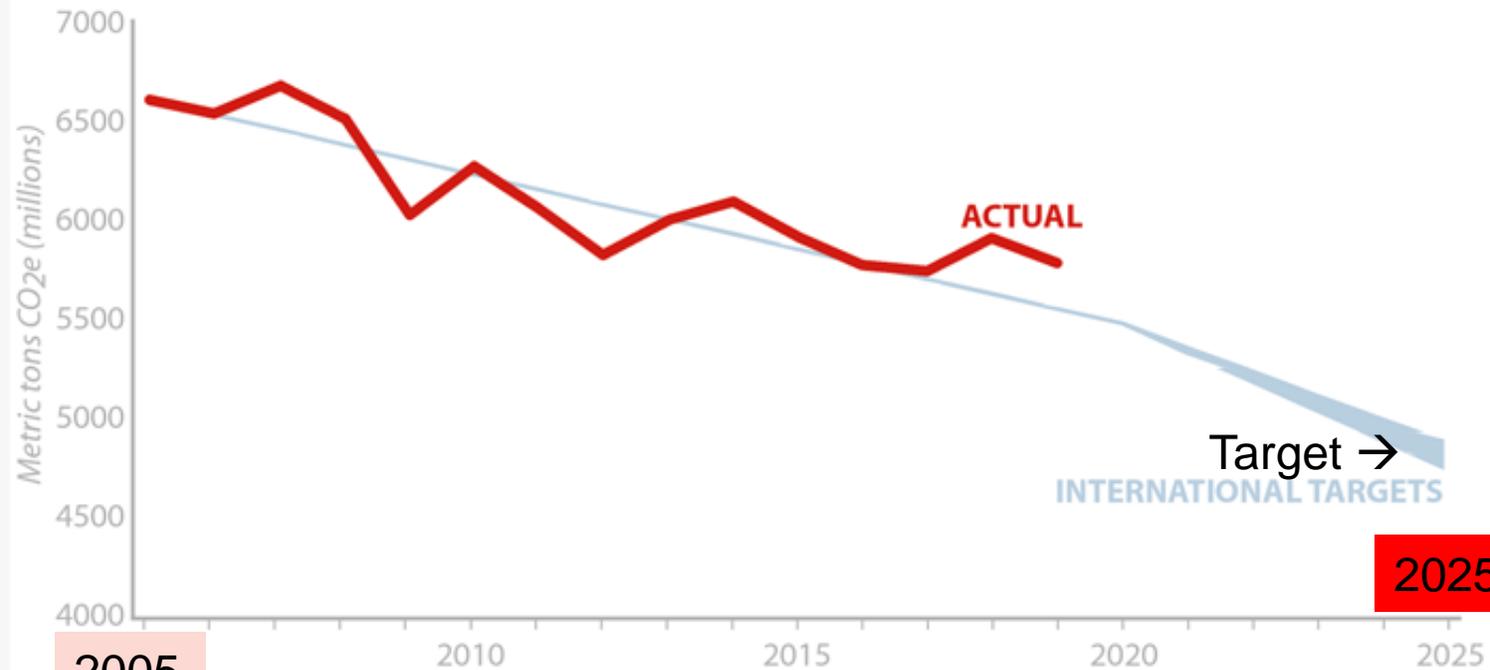
Wildfire sampled by BNL scientists



Clean Energy Research

Implications of Rejoining Paris Accord

U.S. NET GREENHOUSE GAS EMISSIONS RELATIVE TO INTERNATIONAL COMMITMENTS
In millions of metric tons CO₂e, excludes international bunker fuel use, 2005-2019



SOURCE: Rhodium Climate Service

InsideClimate News

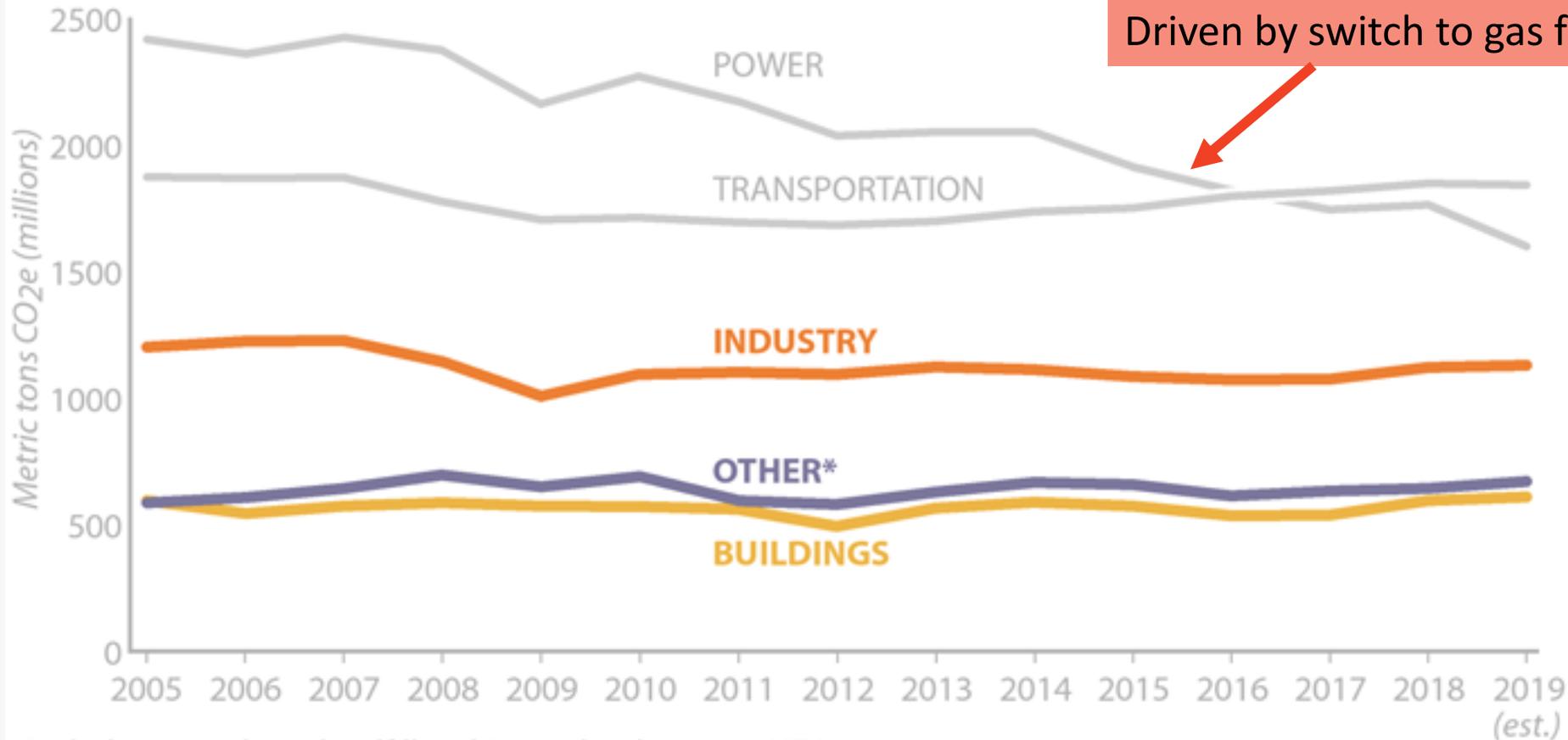
Reduce Greenhouse Gas Emission by 28% from 2005 levels by 2025.

Need to aggressively implement options to **AVOID, UTILIZE & REMOVE** CO₂.

Many options (biofuels, expanded forests, increased uptake of CO₂ in soil, solar) are constrained by available land surface and cannot be scaled to address the problem entirely.

U.S. NET GREENHOUSE GAS EMISSIONS BY SECTOR

In millions of metric tons CO₂e, excludes international bunker fuel use, 2005-2019



Driven by switch to gas from coal

Little or no overall progress on other sectors.

Challenge to de-carbonize aviation, long-haul trucking, cement industry, fertilizer industry.

*Includes agriculture, landfills, oil & gas development, HFCs

SOURCE: Rhodium Climate Service

InsideClimate News

Biology

Foundational plant biology to enable the improvement of feedstock crops for the production of sustainable biofuels and bioproducts

Fundamental Biochemical Plant Science Research

- *Understand plant metabolism and its regulation in detail to provide pathways to development of improved biofuel crops or chemical feed stock crops.*
- *Once of the major efforts is to find a replacement for jet fuel*

Science Headlines [RSS](#) | [View All »](#)

Study IDs Link Between Sugar Signaling and Regulation of Oil Production in Plants

03.17.17 By exploring the details of this delicate energy balance, a group of scientists from the U.S. Department of Energy's Brookhaven National Laboratory has identified a previously unknown link between a protein that maintains plant sugar balance and one that turns on oil production.

[Read More](#)

Sweet Signal: How Sugar Levels Tell Plants When To Make Oil

Plants' Oil-Production Accelerator Also Activates the Brakes

Scientists discover seemingly paradoxical mechanism for regulating oil synthesis

June 20, 2019



Forbes

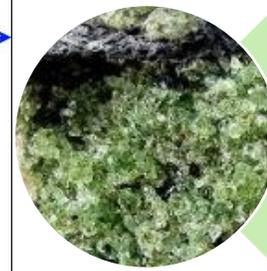
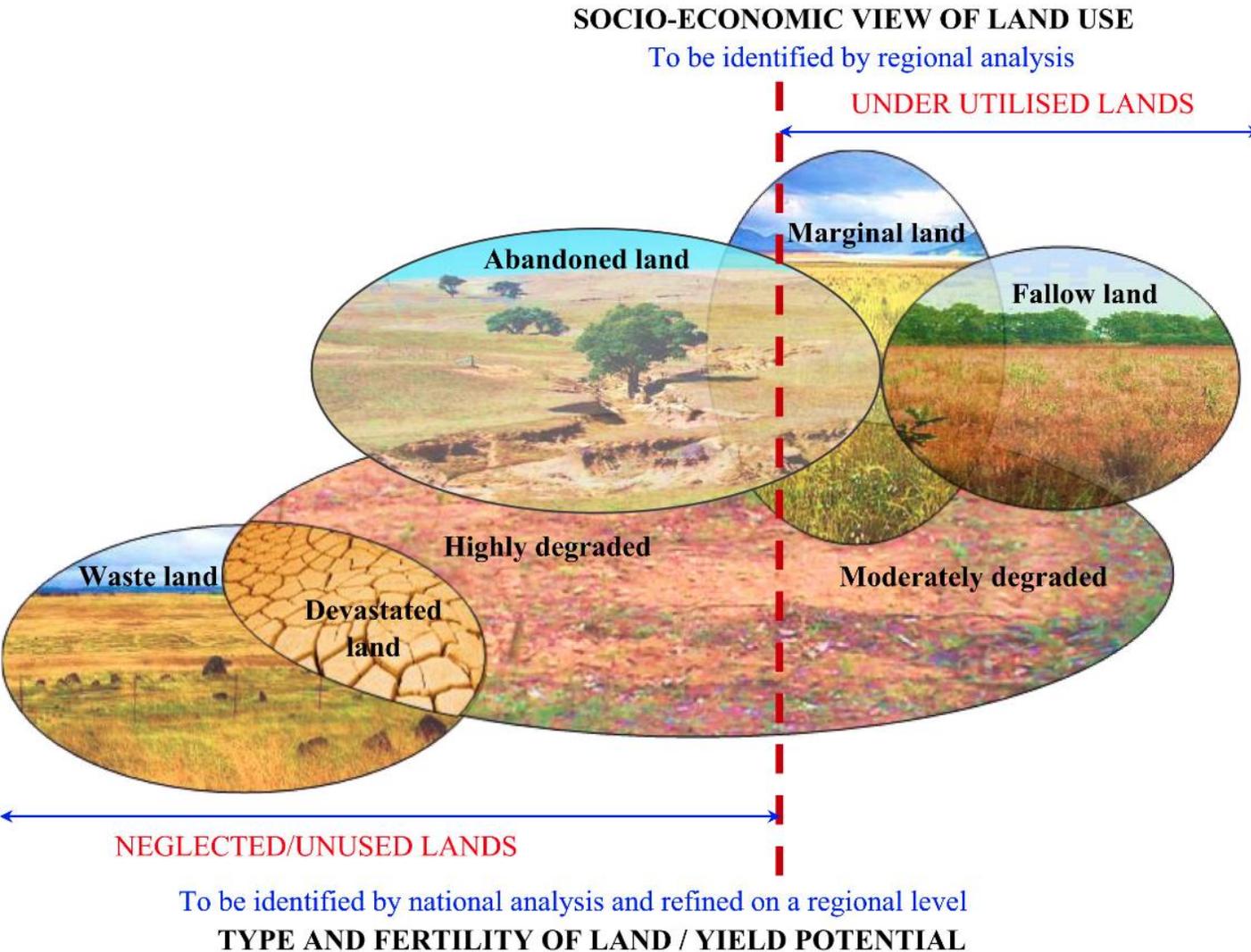
Scientists Breed Oil-Rich "Fat Plants" That Could Be The Biofuel Of The Future

These plants could produce 36 billion gallons of biofuel each year.

by Gina Tomaine October 4, 2017



Possible Bioenergy Roadmap



Amend soil with crushed basalt

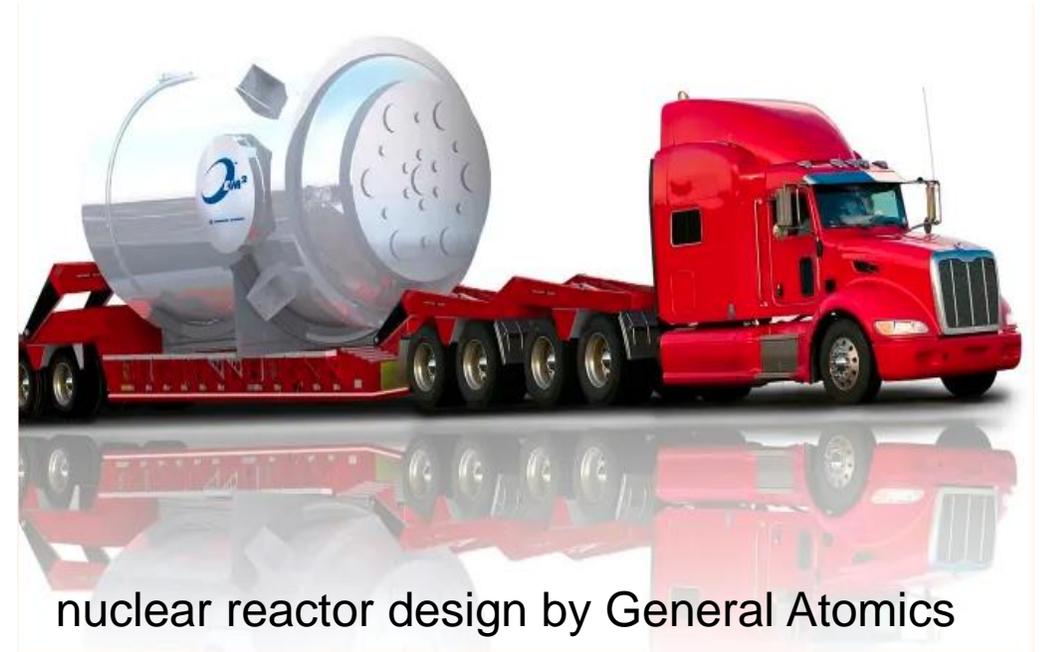


Select or design perennial bioenergy crops

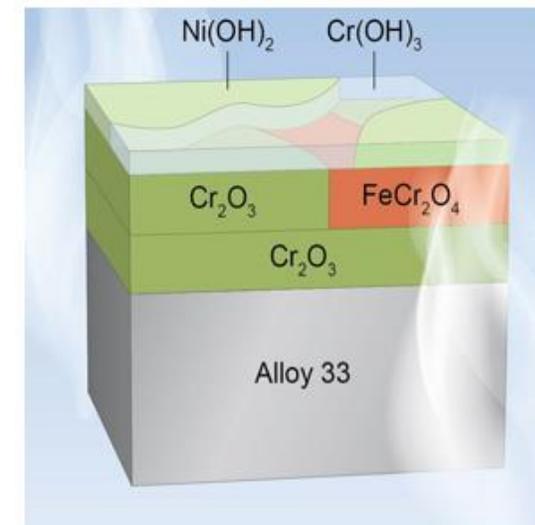


Develop bioproduct/fuel economy and enhance soil carbon storage

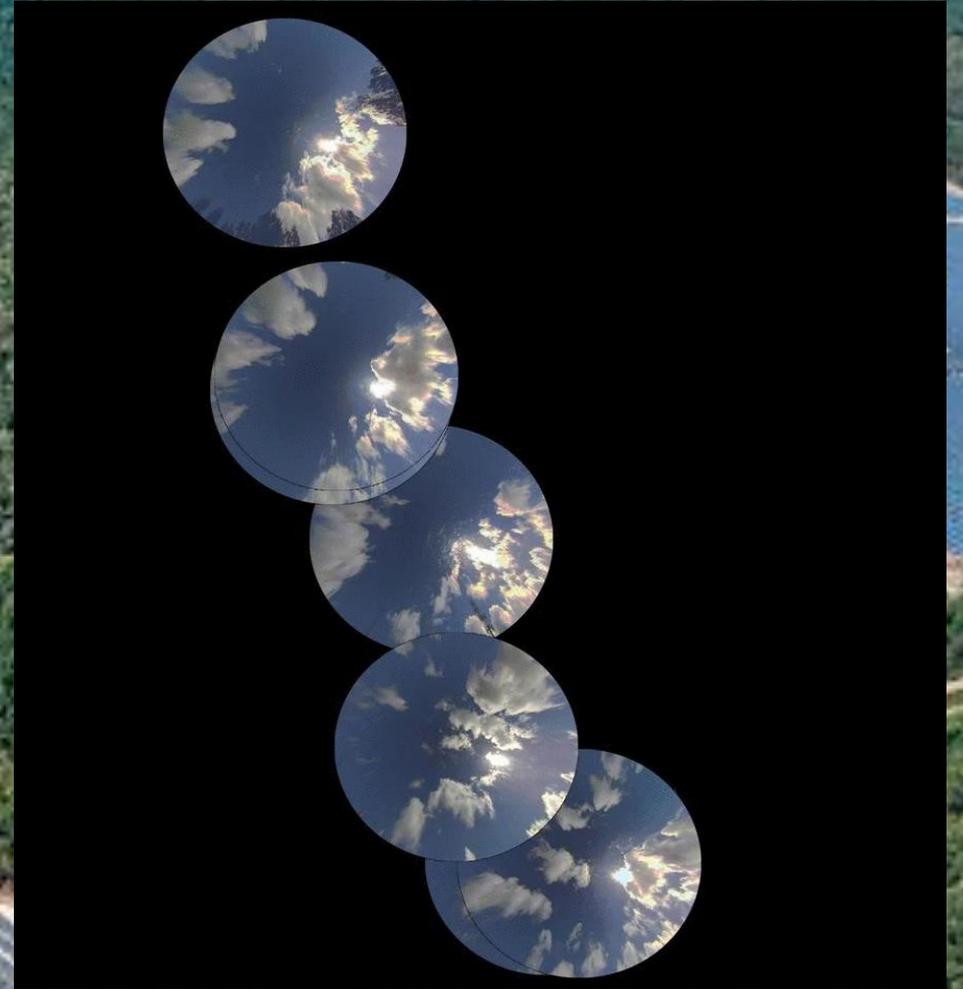
Edrisi: <https://doi.org/10.1016/j.rser.2015.10.050>



nuclear reactor design by General Atomics

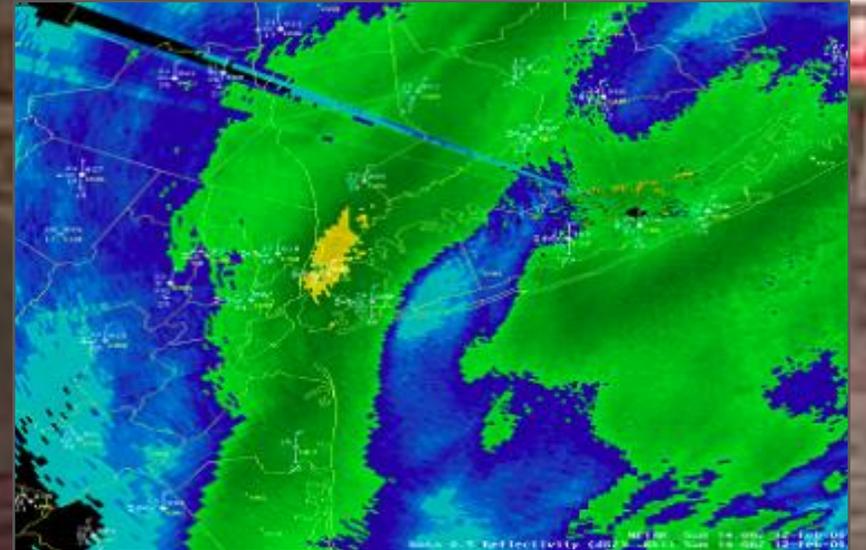


Solar Forecasting at Operational Timelines



Resiliency and Damage Forecasting

- Use weather radar data and outage data to develop insights that lead to a prediction where most outages will occur for a given storm
- Allows utilities to pre-stage crews and shorten outages
- Project frequency and intensity of extreme events





BNL Brookhaven
National Laboratory

